

Zinchuk V., Kugai K.

Kyiv National University of Technologies and Design

TUBE MEAT: THE END OF LIVESTOCK ERA

Abstract. *The article deals with the issue of eating meat, namely the ethical aspects of the problem. Eating meat leads to significant increases of harmful emissions to the atmosphere. Global climate change and multiple problems are the result of it. You can't make all people go vegan, but you can grow artificial meat from animal stem cells. The production of this product is too expensive satisfaction for now but it has its own advantages. Over time it will almost completely replace the real meat product.*

Keywords: *emissions; climate change; artificial meat; stem cells.*

Зінчук В.В., бакалавр, Кугай К.Б., старша викладачка

Київський національний університет технологій та дизайну

М'ЯСО З ПРОБІРКИ: КІНЕЦЬ ЕРИ ТВАРИННИЦТВА

Анотація. *Стаття аналізує проблему споживання м'яса в їжу, а саме етичні аспекти цього питання. Споживання м'яса призводить до значного збільшення шкідливих викидів в атмосферу. З цього впливає глобальна зміна клімату та численні проблеми. Не можна змусити всіх людей перейти на вегетеріанство, але можна вирощувати штучне м'ясо зі стовбурових клітин тварин. Виробництво такого продукту поки занадто дороге задоволення, але має свої переваги. З плином часу воно майже повністю замінить справжній м'ясний продукт.*

Ключові слова: *викиди; зміна клімату; штучне м'ясо; стовбурові клітини.*

Introduction. Cultivated meat is an alternative protein produced by containing muscle cells in a tube without slaughtering animals. The prototype of cell-growing meat was realized by cultivating stem cells gained from the skeletal muscles of pigs to achieve the greatest similarity with natural meat. So far there are experimental works, technology upgrading and affordability, but in the next 1.5–2 years this product will appear on the shelves of our supermarkets. We believe it has a great future to solve extremely complex environmental, food and even ethical problems.

Plant meat ideas were introduced in the late 1980s. In our time it has become very popular. As a result, plant meat looks and tastes almost similar to natural meat. Currently there is approximately 40 per cent of the world's habitable land which is used for livestock and dairy production. If at least half of the population was able to switch to meat and milk from tubes people, then would be able to obtain an "extra" territory the size of North America.

Dutch scientist Willem van Hélen is unofficially considered to be a "father" and the main mastermind of the technology "meat from a test tube". During the Second World War he spent several years in Japanese capturing, constantly suffering from a shortage of food. This seems to have generated his further interest in the issue. Similar studies have been held in the United States, where NASA has funded experiments to grow stem cells of fish and mice muscle fibres. But controlling the development of the cow's muscle fibres was much more difficult. Moreover, a full-scale experiment in which a whole chop could be obtained was too expensive.

In 20 years, there will be a shortage of water and meadows to pasture livestock if meat production is not developed well. Now we need 25,000 litres of water to produce a whole kilo of meat. By the way, meat consumption is increasing every year because the world's population is also growing. The main consumers of meat replacements are "conscious meat eaters", who choose healthier food when possible. The plant-based protein is easier to digest and it contains the same amino acids as common meat.

Problem statement. The main purpose of the study is to analyze the issue of meat consumption and its consequences such as environment contamination, global climate change. The particular attention is paid to the ethical aspects of the problem.

Much can be said about the environmental and ethical advantages of producing any product, but most buyers will be primarily interested in three main factors: taste, price, and health safety. Today, meat substitutes are produced based on soybean, wheat and fungal proteins. The experience of their production and realization is very interesting subject for marketing. Their entry into the market at first was also considered as a culinary breakthrough. But over time, soy “meat” and similar products could occupy only a small part of the market. Experience has shown that culinary characteristics have become a major barrier to the development of this protein product. Mass buyer simply did not like the taste, smell (more certainly its lack), structure and other qualities even under conditions of acceptable price.

The question of price, as well as culinary qualities, is a matter of time. The first burger which was made in 2013 from cultivated meat, was worth \$335,000. This is not surprising, since the entire technological and production chain was used for its manufacture. However, the cost of producing experimental samples of cultivated meat has been falling since 2013. To compete with traditional meat, the price of cultivated meat must be at or below its level. This is what scientists, technology developers and manufacturers will want.

Some American companies are working to produce cultivated fish fillets rather than meat. Because fish are cold-blooded, fish cell cultivation needs lower temperatures and less energy than producing laboratory meat. Meat production in bioreactors also needs additional ingredients. For example, some vitamins are added to the nutrient medium. However, the most dangerous pathogen of food is the product of modern industrial livestock. Growing meat in bioreactors avoids many of the risks that livestock has. This technology reduces the risk of a pathogen and pollutants and can significantly reduce the risk of epidemics worldwide, such as avian influenza and African pig plague.

There are already about 20 companies in Europe that invest in cultivated meat technologies. The United States is currently trying to speed up the development of standards for cultivated meat. They want to keep up with the Europeans. This is not surprising, because Dutch and American companies that invest in the technology of cultivated meat are planning to enter the market with a new product at the same time, as early as 2021. Cost overrun of land and water resources, greenhouse gas emissions and waste management will become more complex and expensive in close future. Considering the high cost of resources, the growing demand for meat and the rise in environmental safety standards, livestock production will become more expensive, which will generate demand for cheaper alternatives. Even today, it is predicted that beef, which is the most consumable and environmentally dangerous animal meat, will slowly become premium food.

While price, safety and quality are the highest priority for most consumers, for some buyers (especially in developed countries) production ethics and environmental safety are the most important arguments. This is especially true for young people, many of whom are concerned about the treatment of farm animals. It is the category of the population that now has the largest percentage of vegetarians, and some people does not become vegetarians just because of imperfect cooking alternatives. Therefore, if the cultivated meat is little different from the normal meat, then the number of consumers of the new product will grow in many times.

It is clear that young people will increasingly influence demand and they are targeted for cultivated meat, including for ethical reasons. In recent years, the issue of animal ethics and the avoiding of animal abuse has changed significantly in developed countries. It is moving smoothly from moral responsibility to law. Although Ukraine is only beginning to see these

developments, the general trend is clearly to demand humane animal housing. In fact, one of the reasons for the active development of industrial meat livestock production in Ukraine is the introduction of increasingly strict animal housing requirements in EU countries, which increases the cost of production for European farmers and becomes profitable for Ukrainian agricultural producers. Sooner or later, however, these standards will reach Ukraine in total.

The technology of producing cultivated meat also needs animals. However, these animals act only as cellular donors, so there is no need to keep large numbers of them. Thus, large-scale production of cultivated meat will mean a significant reduction in the number of domestic animals, which will improve their situation by reducing the number of livestock farms. The problem of the housing of animals on farms cannot be hidden. No one believes in the provincial idyll, when the animal was able to at least live a comfortable life under the blue sky and on the green grass of the pasture anymore. It used to be, but today it's more the exception than the rule. Cultivated meat has some absolute ethical advantages compared to modern livestock production. Researchers in marketing point to an increasing awareness among buyers in developed countries, who are also the largest consumers of meat products.

In livestock breeding, genetic engineering and cloning have been considered as one of the most promising areas for the development of the industry for years. However, the issue of ethics itself is one of the greatest obstacles to the creation of genetically modified farm animals. Harsh law and protests by civil society organizations about the development of genetically modified organisms (GMOs) are on the way, in a number of developed countries. Thus, the production of cultivated meat could put an end to debates over the suitability of GMO cultivation and cloning in terms of environmental safety, health and biological ethics.

Indeed, the advantages of artificial meat over natural meat are obvious:

1. Safety. The meat in the tube will be completely clean. This completely excludes the risk of infection with avian and swine influenza, rabies and salmonella. It will be possible to regulate the fatness in meat, which will reduce the heart disease.

2. Savings. Production of 1 kg of poultry, pork and beef requires 2, 4 and 7 kg of grain, accordingly. Not to mention the time spent on raising livestock. Obviously, there is no economy in this case. In the laboratory, you can grow as much meat as you need and not a gram more. This will save the natural resources and food needed to grow animals and birds.

3. The environment. Many people criticize the cost of traditional agricultural methods used to raise farm animals. If you look at the resources needed to make a hamburger, it is equivalent to the environmental consequences after a train accident.

4. Humanity. Animal welfare groups readily supported the idea of producing meat in laboratory conditions, as it excluded the exploitation and killing of livestock and poultry.

Results and discussion. The agricultural sector is the most destructive sector for natural environment on the planet, and livestock is the most important factor in its structure. Today, about 70% of all agricultural land is used for livestock production. About 40–50% of global cereal yields are used to feed domestic animals. In developed countries, this percentage is much higher. If humankind does not decide to switch completely to a vegetarian diet, then today there is a need for a fundamental change in the way meat is produced. Otherwise, instead of satisfying human appetites, modern livestock will simply eat away the global ecosystem. Specifically, the lack of natural ecosystems and their further extinction is the most immediate environmental threat. As we know modern animal husbandry (driven by population and consumption growth) is central thing in this catastrophic scenario.

It is also believed that one quarter of all greenhouse gases are produced in agriculture. This is primarily through the destruction of natural ecosystems that regulate the carbon dioxide cycle in biomass. Their transformation to pastures and lanes for the production of fodder destroys this natural cycle. Supporters of new technology believe that the switch to cultivated

meat and plant proteins should reduce greenhouse gas emissions, being included in the production of cultivated meat in cities, which will significantly reduce logistics costs. It is not easy to determine the energy cost of producing such meat because mass production has not begun in total. There are only previous estimates, which vary considerably. However, both optimistic and pessimistic estimates are striking for the cost difference between farm beef and laboratory.

In general terms, the technology looks like this. A tiny amount of cells is taken from animal's body. Cells are placed in a bioreactor, where a nutrient medium is supplied and where a muscular mass is formed. Sometimes substances that are produced by special strains of *Escherichia coli* bacteria can be used. In addition, vitamins are added to the nutrient medium, but the weight of all these supplementary nutrition components is less than 0.1% of the nutrient medium weight. If you consider all the food additives, growth stimulants, veterinary drugs and antibiotics that are used to feed animals, it is not strange that cultivated meat is also called pure meat. Moreover, it is much easier to control the source of water or waste in the closed cycle of a biotechnology plant than to control the run-off of herbicides, fungicides and pesticides from the surface of fields where fodder crops are grown for livestock.

It still needs to be "fed" to grow cultivated meat. Today, two main sources of resources for the nutrient environment are being considered. The first is grain and pulse crops. For example, corn produces starch and glucose, glutamine amino acids and some other components. Soy is also used to produce hydrolysate, which is the source of many other amino acids for proteins. In order to create such a nutrient, its components go through all stages, from planting, searching and harvesting in the field. Despite the long technological chain and the high energy costs, such technology is still more effective in some respects than feeding livestock. Proponents of new technology argue that it is impossible to assess the stability of cultivated meat on the basis of past production techniques.

Researchers and developers are increasingly looking at alternative sources for its development. That is why one of the most detailed scientific works of the evaluation of cultivated meat is the calculations made at Oxford University, where a fundamentally new source, the hydrolysis of cyanobacteria, was a basic element of the nutrient medium. Nutrient and volume gains occur in this technology through time and volume factors. In fact, the basis for the nutrient environment is phytoplankton, which is grown in special pools. Like any phytoplankton, cyanobacteria grow extremely quickly in the water column. Once hydrolyzed, their biomass produces nutrient part for growing meat in a test tube. According to these studies, if all EU countries completely abandon livestock meat and switch to cultivated meat, then total EU greenhouse gas emissions will decrease by 43% per year. Total water consumption will decrease by 21%, and 38% of EU territory will be released from commercial use.

The authors of the study note that cultivated meat has great conservation potential. Firstly, it is possible to return natural ecosystems (forests, swamps) to free land. Secondly, technology will stop hunting for meat on rare animals, because the meat of such animals can be cultivated. Of course, uncertainties about the environmental impact of cultivated meat remain high, so research and development of cultivated meat technology remains necessary.

Really, we should be very careful about this technological utopia. Without changes in mentality, lifestyle and legal framework, technological breakthroughs often turn into "horizon chasing". Sometimes technology does not remove environmental threats, but rather increases them. It is enough to recall the agrarian green revolution of the mid-20th century when new technologies have increased yields but have not solved either the food or the environment problem. It only provoked their following focus through a demographic explosion and a consumption cult. Without appropriate law and administrative regulation, all the benefits of cultivated meat technology may be lost. This will also be the case if most of the lands released

from the agriculture sector will be allocated for development or energy crops rather than for the recovery of natural ecosystems. Like the "green revolution" it can provoke a new demographic explosion, because there will be an illusion that there is now enough food on the planet for new billions of people.

Nothing can replace normal population policy and economic consumption. An invention is often easier to do than push into mass. Otherwise, there wouldn't be 8 billion on the planet when the population has long since developed reliable means of contraception and has learned enough about physiological features for civilized and humane family planning. But the mental factor (culture, behavior, habits, traditions, stereotypes) is stronger than technology. Another example is that, due to constant technical improvements, the energy consumption of each individual device unit is falling, but global energy consumption is increasing.

The UN calls on humanity to reduce meat consumption through environmental threats. Unfortunately, human lacks the will to change his cooking habits even in the face of a global threat. So for the time being, technology will have to adapt to the whims of people. However, the psychological factor will always decide human behaviour. Therefore, humanity has to rely on technology. But, strategically global psychology, political will and governance are key to preventing environmental collapse. They must influence not only on demographics and consumption, but also on technological choices. A man should not be given what he wants, but what he really needs. Until 2030, it's going to be cheaper to make synthetic meat. Also it's going to cost a lot less to make meat in the lab.

Conclusions. No doubt, it is reasonable to be concerned about the safety of such foodstuffs. It's a new technology and production mistakes can happen. It is known that there are no short-term side effects of eating an artificial product other than those seen in the consumption of ordinary meat. Long-term studies are also not yet available because this form of meat production is in its primary state. In theory, however, there should be no side effects at all other than those observed with normal animal meat. Because there is no chemical difference between the muscular part of the cultivated meat and the same parts in the regular one.

To cut long story short, artificial meat may even be safer because the chances of bacterial infection are almost non-existent. Traditional animal meat is prone to infection with listeria, coliform, Campylobacter, etc. The meat that is cultivated will also be free of all pesticides and tranquilizers. But there is still a need for preservatives to protect against yeast and fungi. Taking all this into account, synthetic meat is 100% likely to be dangerous. But it's not as dangerous as usual. Anyway, consumers will determine the success or failure of artificial meat in the end.

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